PREPARATORY MATERIALS FOR A WORKSHOP:

PLANNING RESEARCH TO UNDERSTAND POPULATION-LEVEL EXPOSURES ASSOCIATED WITH ONSHORE DEVELOPMENT OF OIL AND NATURAL GAS FROM UNCONVENTIONAL RESOURCES

SEPTEMBER 12-13, 2018 | AUSTIN, TX

THE HILTON AUSTIN, 500 EAST 4TH STREET, AUSTIN, TEXAS, 78701

The purpose of HEI's Energy Research Program is to identify and conduct highest priority research on the potential population exposures and health effects from the onshore development of oil and natural gas from shale and other unconventional resources (UOGD) across the United States.

This package contains:

- → **Workshop agenda** along with the **workshop's purpose** and **charge questions** for all participants
- → **Description of HEI's research planning workshops and expected products** with an introduction to the Energy Research program and a description of how this workshop will facilitate research planning by HEI's Energy Research Committee
- → **HEI Energy Research Committee Biographies**
- → **Workshop Speaker Biographies**
- → **Participant list** including individuals representing academia, government, non-governmental organizations, and industry
- → **Logistical information**, including a map and directions from the airport to the workshop venue and transportation options
- → **Coming separately...a brief report summarizing the Committee's progress**

A separate attachment to this email contains:

- → **Bibliography** and an accompanying brief overview of the its contents

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Participants' role at the workshop:

- Contribute your perspective to the Committee's impartial, interdisciplinary review and interpretation of exposure, toxicity, and risk assessment literature
- Lend your voice to the Committee's planning for original population-level exposure research to fill important knowledge gaps.

A BUFFET LUNCH WILL BE PROVIDED ON SEPTEMBER 12TH AND A BREAKFAST ON SEPTEMBER 13TH

FOR MORE INFORMATION: Donna Vorhees (617-488-2317; dvorhees@healtheffects.org)

The Health Effects Institute (www.healtheffects.org) is an independent, non-profit research institute funded jointly by government and industry to provide credible, high quality science on air pollution and health for air quality decisions. Periodically, HEI also receives funding from foundations for special projects. HEI sponsors do not participate in the selection, oversight or review of HEI science, and HEI's reports do not necessarily represent their views.

HEI Research Planning Workshop

Understanding Population-Level Exposures Associated with Onshore Development of Oil and Natural Gas from Unconventional Resources

Hilton Austin, 500 E 4th St., Austin, TX 78701
September 12-13, 2018

WORKSHOP AGENDA

Purpose of Workshop:

The workshop provides an opportunity for the Energy Research Committee to hear from a broad range of stakeholders about their expert opinions and perspectives on the literature, important knowledge gaps, and research priorities along with the criteria used to define the priorities. This workshop is the second of two workshops. Presentations and group exercises will build on progress made at the July workshop.

The Committee will consider information received during the workshop as it conducts its own review of the literature and formulates research priorities for population-level exposure research. With the benefit of an interdisciplinary group of experts at the workshop, HEI's Energy Research Committee expects to complete a framework of potential human exposure pathways that can serve as a roadmap for research planning.

Workshop Charge Questions:

1. How can existing data be leveraged to understand potential exposures from UOGD?
2. What potential UOGD exposures are not well understood with existing data and merit original research?
    a. What exposure pathways and phases of UOGD should be the focus?
    b. In conducting such research, what are your recommendations for considering regulatory, environmental, and industry practice variability over time and across regions?
    c. What is the value of the research for decision-makers (e.g., regulators, industry, community members, and scientists conducting research)?

EPA-HQ-2019-0221

Workshop Chair: George Hornberger, Chair, HEI Energy Research Committee

September 12, 2018 (10:30am to 5:30pm)

TIME	TOPIC	SPEAKER
10:00-10:30 AM	*Registration*	
10:30-11:00 AM	**INTRODUCTIONS AND WORKSHOP OVERVIEW**	
10:30-10:40	Welcome	Bob O'Keefe, Vice President, HEI
10:40-11:00	Introductions	George Hornberger, Chair, HEI Energy Research
11:00-11:10	Workshop Objectives and Charge Questions	Donna Vorhees, Director of Energy Research, HEI
11:10 AM-12:00	**THE COMMITTEE'S PROGRESS**	
11:10-11:45	Overview of exposure literature review and research planning	George Hornberger and HEI
11:45-12:00	Discussion	
12:00-1:00	*Lunch*	
1:00-3:00 PM	**PANEL DISCUSSION: Federal and State Oil and Gas Policy - Trends and Research Needs**	
Panel Talking Points:		*Panelists (in alphabetical order):*
1. HEI's Energy Research Committee is charged with recommending population-level research to understand potential human exposures associated with onshore unconventional oil and natural gas development in the United States. To do so, the Committee needs a clear understanding of current national- and state-level oil and natural gas regulations and guidance. For this reason, we ask each panelist to describe current oil and natural gas policy in their jurisdiction and anticipated future trends, focusing on policies most important for the protection of public health (by minimizing exposures). **2.** HEI's Energy Research Committee has been charged with recommending high priority research that is relevant to policy decisions. To this end, we ask each panelist to advise the Committee about human exposure research related to unconventional oil and natural gas development that they would find most useful.		Megan E. Garvey (Senior Counselor to the Regional Administrator Region 8) Michael E. Honeycutt (Director, Toxicology Division, Texas Commission on Environmental Quality) James C. Kenney (Senior Policy Advisor for Unconventional Oil and Gas, Office of Congressional and Intergovernmental Relations, USEPA) Scott Thompson (Executive Director, Oklahoma Department of Environmental Quality) Martha Rudolph (Director of Environmental Programs, Colorado Department of Public Health and Environment) Clint Woods (Deputy Assistant Administrator, Office of Air and Radiation, USEPA)
3:00-3:30 PM	*Break*	
3:30-5:15	Group Exercise #1 followed by facilitated discussion	
5:15-5:30	*Discussion; wrap up for the day; review plan for day 2*	

September 13, 2018 (8:00am to 12:00pm)

TIME	TOPIC	SPEAKER
7:00-8:00 AM	*Breakfast*	
8:00-10:15 AM	**DATA MINING: How can we leverage the data that already exists?**	
8:00-8:25	Working smarter not harder, unearthing oil and gas data using intelligent geoinformatics	Kelly Rose (U.S. Department of Energy, National Energy Technology Laboratory)
8:25-8:45	Stalking the Wild Dataset: Informing Policy with Evidence	Kate Konschnik (Duke University)
8:45-9:05	Using Geochemistry Data to Identify Groundwater Quality Issues in Shale Gas Production Areas	Tao Wen (Pennsylvania State University)
9:05-9:25	Existing VOC Measurements from the Colorado Front Range's Oil and Natural Gas Region: Availability, Value, and Limitations	Rebecca Hornbrook (University Corporation for Atmospheric Research)
9:25-9:45	Oil and Gas Emission Inventories and Applications for Estimating Impacts to Health and Welfare	Tom Moore (Western States Air Resources Council) and John Grant (Ramboll)
9:45-9:55	Filling in the Gaps in Monitoring Data with Satellite Imaging	Alan Krupnick (Resources for the Future)
9:55-10:15	Air Quality Data from CDPHE's Community Exposure Investigations	Tami McMullen (Colorado Department of Public Health and Environment)
10:15-10:20 AM	*Brief Break before Breakout Groups*	
10:20-11:50	Group Exercise #2 followed by facilitated discussion	
11:50-12:00	Wrap-up with next steps in research planning and opportunities to comment before RFQ release	

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Health Effects Institute's Energy Research Program

Research Planning Workshops

~Background Information~

Purpose of the Energy Research Program

The purpose of HEI's Energy Research Program is to identify and conduct highest priority research on the potential population exposures and health effects from the onshore development of oil and natural gas from shale and other unconventional resources (UOGD) across the United States. With resource development projected to continue, alongside growing efforts to switch to renewables and conserve energy, a source of high-quality, impartial science is needed to support decisions about how best to ensure protection of public health in the oversight and implementation of this development.

HEI's Energy Research Committee

The Energy Research Committee (the "Research Committee") is a body of subject-matter experts that independently defines and oversees the Energy Research Program.

- George Hornberger, Vanderbilt University, Director, Vanderbilt Institute for Energy & Environment, Nashville, Tennessee (Chair)
- Shari Dunn-Norman, Missouri University of Science and Technology, Rolla, Missouri
- Elaine M. Faustman, University of Washington–Seattle
- Howard Hu, University of Washington and University of Michigan
- Judy S. LaKind, LaKind Associates, LLC, Catonsville, Maryland, and Adjunct Faculty, University of Maryland–Baltimore
- Armistead (Ted) G. Russell, Georgia Institute of Technology, Atlanta
- Stefanie Ebelt Sarnat, Emory University, Atlanta, Georgia

The Workshops

General Approach

Two *Exposure and Risk Screening Workshops* will draw on existing knowledge, relevant data and literature regarding potential UOGD exposures to:

- Review what is known about potential UOGD exposures, their likelihood, and significance for health;
- Develop a conceptual model of potential exposures to UOGD;
- Discuss criteria for identifying and prioritizing research; and
- Provide advice to the Research Committee on exposure topics that warrant research.

The first workshop allows for reviewing the literature and identifying preliminary research priorities. Between the two workshops, the Research Committee will continue its review of the literature along with information and public comment received during the first workshop and subsequent public comment period. The second workshop allows for continued discussion of the literature and more refined research priorities for consideration by the Research Committee. Discussions and recommendations from both workshops will help to guide the Research Committee as it selects exposure topics that warrant study and prepares RFQs.

Health Effects Institute's Energy Research Program

Workshop Organization

July 11-12, 2018 Workshop
Denver, Colorado

- Review UOGD operations and trends affecting the potential for exposure
- Review and develop a conceptual model of potential UOGD exposures
- Discuss criteria for identifying and prioritizing research options
- Suggest priorities for research that the Research Committee should consider for funding

Summer 2018
Interim Analyses

- Conduct additional review of the literature to support discussion of research options at a second workshop

September 12-14, 2018 Workshop
Austin, TX

- Continue discussion of the literature
- Suggest priorities for population-level exposure research that the Research Committee should consider for funding

Participants

HEI seeks workshop participants that bring the necessary breadth of expertise and experience, along with an ability to impartially interpret and use scientific information. Participants will come from federal, state, regional, and local government, academia, industry, and non-governmental environmental, public health, and community organizations.

Products

HEI will summarize workshop proceedings in brief reports and oversee preparation of a peer-reviewed article that summarizes the literature review and recommendations for research priorities. Finally, but perhaps most important, based on the workshop discussions, the Research Committee will prepare a draft RFQ for exposure studies for review by sponsors before final issuance and solicitation of study proposals.

For More Information:

Donna J. Vorhees, ScD
Telephone: 617-488-2317
Email: dvorhees@healtheffects.org

Webpage:
https://www.healtheffects.org/energy

ENERGY RESEARCH COMMITTEE BIOGRAPHIES

HEI Energy Research Program

George M. Hornberger (Chair)

Dr. Hornberger is a University Distinguished Professor at Vanderbilt University, where he directs the Vanderbilt Institute for Energy and Environment and has a shared appointment as the Craig E. Philip Professor of Engineering and as Professor of Earth and Environmental Sciences. Previously he was a professor for many years at the University of Virginia where he held the Ernest H. Ern Chair of Environmental Sciences. He has been a visiting scholar at the Australian National University, Lancaster University, Stanford University, the United States Geological Survey, the University of Colorado, and the University of California at Berkeley. Dr. Hornberger's research centers on the coupling of field observations with mathematical modelling. Recognizing that water resources are under pressure from many human activities from climate change to urban development, he pursues broadly interdisciplinary research focused on coupled natural-human systems. The goal of the research is to understand how climate, groundwater, surface water, and human abstraction of water interact in complex ways. Current projects include work in Sri Lanka on adaptation to drought and in the United States on how cities evolve water conservation practices. He has published extensively, with numerous scientific papers, book chapters, and books.

Dr. Hornberger has served on numerous boards and committees of the National Academies, most recently as chair of the Committee on "Future Water Resource Needs for the Nation: Water Science and Research at the U.S. Geological Survey" and chair of the Water Science and Technology Board. He has also served other organizations, for example, he chairs the Geosciences Policy Committee of the American Geosciences Institute and serves on various committees of the Geological Society of America, the American Geophysical Union, and other organizations. In 2015, he recently completed service as the chair of the Health Effects Institute Special Scientific Committee on Unconventional Oil and Gas Development. Before that in 2013, he chaired a related National Research Council Committee on Development of Unconventional Hydrocarbon Resources in the Appalachian Basin. He previously served as an editor on several highly regarded journals. Dr. Hornberger won the Robert E. Horton Award (Hydrology Section) from the AGU in 1993. In 1995, he received the John Wesley Powell Award from the USGS. In 1999, he was presented with the Excellence in Geophysical Education Award by the AGU and in 2007 he was selected Virginia Outstanding Scientist. Professor Hornberger was elected to the U.S. National Academy of Engineering in 1996. He was also elected a Fellow of the American Geophysical Union in 1994, the Association for Women in Science in 1996, and the Geological Society of America in 2005, received the William Kaula Award from the American Geophysical Union in 2010, and the Harvie Branscomb Distinguished Professor Award from Vanderbilt University in 2017.

Dr. Hornberger holds a B.S.C.E. in Civil Engineering and an M.S.C.E. in Hydrology from Drexel University and a Ph.D. in Hydrology from Stanford University.

Shari Dunn-Norman

Dr. Dunn-Norman is Associate Professor and the former Program Head of Petroleum Engineering at the Missouri University of Science and Technology. Previously, she worked in both domestic and international assignments for the Atlantic Richfield Companies (ARCO), beginning her career as a summer field roustabout and advancing to Senior Operations Engineer at ARCO International. Dr. Dunn-Norman's research has focused on pipeline flow and leak detection, well construction for the protection of underground sources of drinking water, hydraulic fracturing, and well completions. She has over 25 years of combined academic, industrial and consulting experience in well design and well completion technology. She has published extensively, with numerous scientific papers and book chapters and co-authored a book on well construction.

Dr. Dunn-Norman is a member of the Society of Petroleum Engineers (SPE), where she has served on numerous committees. She was elected and currently serves as the National President of Pi Epsilon Tau, the Petroleum Engineering Honor Society. She is also a member and volunteer for the St. Louis Academy of Science and the Missouri Academy of Science. Dr. Dunn-Norman served on the U.S. Environmental Protection Agency Science Advisory Board 2011 Ad Hoc Hydraulic Fracturing Research Advisory Panel, which reviewed EPA's draft "Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources." For more than 20 years, Dr. Dunn-Norman has taught numerous industrial short courses about production engineering and well completions for various companies, such as Petroleum ETC, a private corporation that operates events worldwide on topics ranging from multiphase pumping and artificial lift, to hydraulic fracturing; and Petroskills, a leading world organization in all areas of oil and gas training. Dr. Dunn-Norman has received numerous awards, most recently the Society for Professional Engineers' Distinguished Member Award in 2015 and several excellence in teaching awards.

Dr. Dunn-Norman holds a B.S. in Petroleum Engineering from the University of Tulsa and a Ph.D. in Petroleum Engineering from Heriot-Watt University, Edinburgh, Scotland.

Elaine M. Faustman

Elaine M. Faustman is Professor in the Department of Environmental and Occupational Health Sciences and Director of the Institute for Risk Analysis and Risk Communication in the School of Public Health and Community Medicine at the University of Washington. Dr. Faustman's research includes quantitative risk assessment for non-cancer endpoints, molecular mechanisms of developmental and reproductive toxicity, and in vitro and molecular biological methodologies. She develops decision-analytic tools for communicating and translating new scientific findings into risk assessment and risk management decisions. Dr. Faustman directs the NIEHS/EPA-funded Center for Children's Health Research. She has served as Principal Investigator for the Pacific Northwest Center for the National Children's Study and has directed the Pacific Northwest Center for Human Health and Ocean Studies. The goals of Dr. Faustman's research are to discover the mechanisms that define susceptibility in at-risk populations and to provide linkages across disciplines. She has over 200 peer reviewed research publications and reports.

Dr. Faustman is an elected fellow of the American Association for the Advancement of Science and the Society for Risk Analysis. She has served on the USEPA Science Advisory Board. She previously chaired the National Academy of Sciences Committee on Developmental Toxicology and served as a member for the National Advisory Environmental Health Sciences Council, the National Institute of Environmental Health Sciences (NIEHS)-National Toxicology Program (NTP) Committee on Alternative Toxicology Methods, the NIEHS-NTP Board of Scientific Counselors, the National Academy of Sciences Committee on Toxicology, and the Institute of Medicine Upper Reference Levels Subcommittee of the Food and Nutrition Board. She has just completed two terms as Secretary General for the International Union of Toxicology. She is currently a member of the International Science Council World Data Systems Advisory Board. She served on the U.S. Environmental Protection Agency Science Advisory Board 2011 Ad Hoc Hydraulic Fracturing Research Advisory Panel, which reviewed EPA's draft Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources. Dr. Faustman also served on the executive boards of the Society of Toxicology, the Teratology Society, and the Society for Risk Analysis. She has served as an editor on several highly regarded journals. Dr. Faustman has been honored with numerous awards, most recently the 2016 Josef Warkany Lecturer Award from the Teratology Society, the Distinguished Achievement Award from the Society for Risk Analysis in 2014, and the University of Washington's Outstanding Teaching Award.

Dr. Faustman holds an A.B. in Chemistry and Zoology from Hope College and a Ph.D. in Pharmacology/Toxicology from Michigan State University.

Howard Hu

Howard Hu is Affiliate Professor in the Department of Environmental and Occupational Health Sciences, the University of Washington School of Public Health, as well as Adjunct Professor in the Department of Environmental Health Sciences, University of Michigan School of Public Health. When he joined the Committee, Dr. Hu served as the founding Dean at the Dalla Lana School of Public Health at the University of Toronto (2012-2018). Previously, Dr. Hu was Professor of Occupational and Environmental Medicine at the Harvard School of Public Health and Associate Physician in the Channing Laboratory of the Brigham and Women's Hospital in Boston, Massachusetts (1990-2006), after which he was the NSF International Endowed Chair of the Department of Environmental Health Sciences and Professor of Environmental health, Epidemiology and Internal Medicine at the University of Michigan School of Public Health and Health System (2006-2012). Dr. Hu is a physician-scientist, trained as an internist, occupational and environmental medicine specialist, and epidemiologist. He founded an environmental epidemiology research group that, since 1990, has grown into a multi-institutional and international team of scientists devoted to gaining new insights into the impact of exposure to potential toxicants that are of critical importance to public health and medicine. His environmental and molecular epidemiologic research has focused on heavy metals, potential endocrine disruptors, other neurotoxicants, and carcinogens, with particular interest in exposures during sensitive life stages. Dr. Hu has published more than 300 original papers in the scientific literature, and co-authored and edited several books.

He has served on the Institute of Medicine's Board of Population Health and Public Health Practice, the Board of Environmental Science and Toxicology of the National Research Council, and on the National Advisory Environmental Health Sciences Council for the National Institutes for Health. In 2016, he was elected to Fellowship, Canadian Academy of Health Sciences. He also served as the founding medical editor of Environmental Health Perspectives, the official journal of the National Institute of Environmental Health Sciences (NIEHS). He currently serves on the Board of Directors of the Canadian Urban Environmental Health Research Consortium. Dr. Hu has received numerous awards, including most recently the Linus Pauling Lifetime Achievement Award, the Award of Excellence from the American Public Health Association, and the John R. Goldsmith Award for Outstanding Contributions to Environmental Epidemiology from the International Society for Environmental Epidemiology.

Dr. Hu holds a B.Sc. in Biology from Brown University, an M.D. from the Albert Einstein College of Medicine, and an M.P.H. and Sc.D. in epidemiology from the Harvard School of Public Health. He trained in internal medicine at Boston City Hospital and in occupational and environmental medicine at Harvard.

Judy S. LaKind

Dr. LaKind is President of LaKind Associates, LLC, an Adjunct Associate Professor in the Department of Epidemiology and Public Health at the University of Maryland School of Medicine, and a Fellow-by-Courtesy in the Department of Applied Mathematics and Statistics at The Johns Hopkins University. Dr. LaKind has taught graduate level courses at The Johns Hopkins University and the University of Maryland in risk assessment and aquatic chemistry. Previously, Dr. LaKind was a geologist at the US EPA's Office of Federal Activities, where she was responsible for the evaluation of environmental impact statements and legislative reports. She is a health and environmental scientist with expertise in exposure science, assessment of human health risks, biomonitoring, scientific and technical analysis for regulatory support, and state-of-the-science reviews. Dr. LaKind has spoken and published extensively on children's exposures to environmental chemicals, the implications of uncertainty in the risk assessment process, weighing potential risks and benefits related to chemical use (for example, use of MTBE in gasoline, glycols in de-icing formulations, and chlorination of drinking water for zebra mussel control), the presence of environmental chemicals in human milk, and time-dependence and distributional analysis of exposure.

Dr. LaKind is President of the International Society of Exposure Science. She is a founding member of the International Society for Children's Health and the Environment and is a former member of Maryland's Children's Environmental Health and Protection Advisory Council, the Lead Poisoning Prevention Commission, and the Maryland Pesticide Reporting and Information Workgroup. She is a member of the World Health Organization Survey Coordinating Committee for the WHO Global Survey of Human Milk for Persistent Organic Pollutants (POPs), the HESI RISK21 Advisory Board, and the Maryland Department of Health and Mental Hygiene (DHMH) Cancer Cluster Advisory Committee. Dr. LaKind also served on the Institute of Medicine Committee on Blue Water Navy Vietnam Veterans and Agent Orange Exposure and the US Environmental Protection Agency Science Advisory Board Panel on Perchlorate - Approaches for Deriving Maximum Contaminant Level Goals for Drinking Water. Dr. LaKind has received awards, including the 2017 Society of Toxicology Regulatory and Safety Evaluation Specialty Section Award for Best Paper Contributing to the Field of Regulatory and Safety Evaluation in Toxicology and the 2015 EPA Scientific and Technological Achievement Award Level III for "Providing Critical Models and Information Needed for Exposure and Risk Assessments of Environmental Chemicals in Infants."

Dr. LaKind holds a BA in Earth and Planetary Sciences from Johns Hopkins University, an M.S. in Geology from the University of Wisconsin, and a Ph.D. in Geography and Environmental Engineering from Johns Hopkins University.

Armistead (Ted) G. Russell

Dr. Russell is the Howard T. Tellepsen Chair and Regents' Professor at the Georgia Institute of Technology School of Civil and Environmental Engineering. Dr. Russell's research is aimed at better understanding the dynamics of air pollutants at urban and regional scales and assessing their impacts on health and the environment to develop approaches to design strategies to effectively improve air quality. He currently co-directs the NSF Sustainability Research Network "Environmentally Sustainable, Healthy and Livable Cities" project and co-directed the Southeast Center for Air Pollution and Epidemiology. His research interests include air pollution modeling, aerosol dynamics, atmospheric chemistry, combustion emissions control. He has published over 300 peer-reviewed journal articles, book chapters and major reports.

Dr. Russell is a Fellow of the American Society of Mechanical Engineering and the American Association for the Advancement of Science and is a National Associate of the National Academies. Dr. Russell was a member of EPA's Clean Air Science Advisory Committee (CASAC) and a member of the National Research Council's Board on Environmental Studies and Toxicology, and he continues to serve on associated committees. He chaired the CASAC NOx-SOx, Secondary NAAQS review panel, the Ambient Air Monitoring Methods Subcommittee, and the Council on Clean Air Compliance Analysis' Air Quality Modeling Subcommittee, and was on the Health Effects Institute's Report Review Committee. Dr. Russell has been honored with numerous awards, including the 2015 Distinguished Alumni Award from Washington State University, the 2013 Regents' Professor Award, and he was the Most Influential Individual to 2013 semifinalist for the Intel Science Talent Search.

Dr. Russell holds a B.S. in Mechanical Engineering from Washington State University, and an M.S. and Ph.D. in Mechanical Engineering from the California Institute of Technology, conducting his research at Caltech's Environmental Quality Laboratory.

Stefanie Ebelt Sarnat

Dr. Sarnat is Associate Professor of Environmental Health at the Rollins School of Public Health of Emory University. Her epidemiological research focuses on examining health effects of ambient air quality using population- and panel-based approaches. She leads large-scale time-series studies of ambient air quality and acute morbidity, using emergency department visit data as an indicator of population health. Dr. Sarnat's work on these studies focuses on assessment of ambient air pollution mixtures and metrics of extreme heat, examination of the impacts of exposure measurement error on observed epidemiological findings, and assessing exposure and population factors that may modify health risk. Her studies also include prospective panel-based designs, using detailed field investigation methods to further understand environmental exposure factors and health effects among susceptible and vulnerable populations. She has published extensively in the peer-reviewed literature and has frequently been asked to speak on exposure and epidemiological topics.

Dr. Sarnat is a member of the International Society for Environmental Epidemiology, an editorial board member at Epidemiology, and an associate editor at the Journal of Exposure Science and Environmental Epidemiology. Dr. Sarnat participated on the National Research Council's Committee on Urban Meteorology: Scoping the Problem, Defining the Need and the Health Effects Institute's Review Panel on Ultrafine Particles. She has participated as an expert reviewer of drafts of the USEPA Integrated Science Assessments for particulate matter and nitrogen oxides. She serves as the Point of Contact for Emory University as an observer organization in the United Nations Framework Convention on Climate Change process. Dr. Sarnat has been honored with several awards, most recently the Department of Environmental Health Teaching Award at Emory University and a Supporting Paper for a Level III USEPA Scientific and Technological Achievement Award.

Dr. Sarnat holds a B.Sc. in Microbiology and Immunology and a M.Sc. in Occupational Hygiene from the University of British Columbia and a Sc.D. in Environmental Health from the Harvard School of Public Health.

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HEI Research Planning Workshop

Understanding Population-Level Exposures Associated with the Onshore Development of Oil and Natural Gas from Unconventional Resources

Austin, Texas
September 12-13, 2018

SPEAKER BIOGRAPHIES

Megan E. Garvey
Megan Garvey was appointed to her role as Senior Counselor to EPA's Region 8 Administrator in July of this year. Megan's focus is on Region 8 energy matters, NEPA and Environmental Justice. She also works closely with the Agricultural and Tribal Advisors of the Region. Before coming to EPA, Megan managed regulatory policy for an upstream oil and gas company and volunteered her time as a Commissioner on the Colorado Air Quality Control Commission. Previously, Megan worked for the State of Colorado: as an Assistant Attorney General at the Colorado Attorney General's Office (Air Quality Unit) and as the Compliance Unit Manager for the Air Pollution Control Division of Colorado's Department of Public Health and Environment. Megan started out her career practicing environmental law at a private law firm in Chicago, IL. Megan holds a B.S. in Environmental Studies from Loyola University Chicago and a J.D. from Chicago-Kent College of Law. Megan resides in Morrison, Colorado with her husband and two young sons.

John Grant
John Grant is a Managing Consultant at Ramboll where he has worked for 15 years developing emission inventory and emission control program analyses. He has developed dozens of region and project level oil and gas emission inventories and contributed to state of the science reports on oil and gas emission inventory methods and impacts. He also has extensive experience analyzing emission inventories to understand environmental tradeoffs associated with technological advancements such as vehicle and equipment electrification and adoption of emission control programs.

Michael Honeycutt, PhD
Michael Honeycutt is the director of the Toxicology Division of the Texas Commission on Environmental Quality (TCEQ). His career at TCEQ began in 1996, and he has managed the division of 14 toxicologists since 2003. His responsibilities include overseeing (1) health effects reviews of air permit applications, (2) review of the results of ambient air monitoring projects, and (3) reviews of human health risk assessments for hazardous waste sites. Dr. Honeycutt spearheaded the updating of TCEQ's Effects Screening Levels (ESLs), or toxicity factors for chemicals. The TCEQ ESL derivation procedure has undergone two independent external scientific peer reviews and multiple rounds of public comment (http://www.tceq.texas.gov/toxicology/esl/guidelines/about.html). Dr. Honeycutt serves as a technical resource for TCEQ management and staff on issues concerning air and water quality, drinking water contamination, and soil contamination. He also serves as an expert witness in public and state legislative hearings, participates in public meetings, and has conducted hundreds of media interviews. Dr. Honeycutt is an adjunct professor at Texas A&M University, has published numerous articles in the peer-reviewed literature, serves or has served on numerous external committees, and has provided invited testimony at Congressional hearings. He was recently appointed chairman of USEPA's Science Advisory Board. Dr. Honeycutt received his Bachelor's degree and Ph.D. in Toxicology from the University of Louisiana at Monroe.

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George Hornberger
(See separate compilation of biographies for HEI's Energy Research Committee)

Rebecca Hornbrook
Rebecca Hornbrook is a Project Scientist in the VOC Measurement Group in the Atmospheric Chemistry Observations & Modeling laboratory (ACOM) at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. Her research interests center on the atmospheric emissions and fate of volatile organic compounds (VOCs), both natural and anthropogenic. Dr. Hornbrook received her Ph.D. working with Dr. Jochen Rudolph at York University in Toronto, Canada in 2005, and has over 20 years of experience in the measurement and analysis of gas-phase VOCs. She has been involved in laboratory studies of processes involved in tropospheric oxidation of VOCs, including work she led developing the methodology for measuring stable carbon kinetic isotope effects in the reactions of non-methane hydrocarbons with OH radicals and Cl atoms. She also spent several years measuring hydroperoxy and organic peroxy radicals (HO2 and RO2) using Chemical Ionization Mass Spectrometry (CIMS), studying photochemical processes involved in VOC oxidation. In recent years at NCAR, Dr. Hornbrook has participated in the development and deployment of state-of-the-art instrumentation to measure VOCs in the atmosphere, contributing significantly to the measurement capabilities of the Trace Organic Gas Analyzer (TOGA), a fast online gas chromatograph-mass spectrometer, both in its measurement frequency and growing suite of quantified VOCs. As a member of the TOGA team, she has participated in a large number of NSF and NASA-funded field campaigns, both airborne and ground-based, including OASIS, BEACHON-ROCS, TORERO, DC3, NOMADSS, CONTRAST, FRAPPÉ, WINTER, ORCAS, and most recently, ATom and WE-CAN.

James C. Kenney
James Kenney is the Senior Policy Advisor for Unconventional Oil and Natural Gas at the United States Environmental Protection Agency. In this capacity, Jim coordinates unconventional oil and natural gas activities for the Office of the Administrator across EPA's program and regional offices. Externally, Jim works with oil and natural gas stakeholders on regulatory and policy matters to ensure responsible oil and natural gas development. Such stakeholders include: industry, trade associations, federal and state agencies, tribes, environmental non-governmental organizations (eNGOs) and the public. Within EPA, Jim's career has spanned multiple offices around the U.S., including: Denver, Colorado; Philadelphia, PA; and Washington, DC, helping him bring both a national and local perspective to his current work. Jim earned a Master of Science in Engineering and Bachelor of Science in Engineering Technology from Temple University in Philadelphia, PA. While he is an EPA Headquarters employee, Jim teleworks from Albuquerque, New Mexico where he and his family reside.

Kate Konschnik
Kate Konschnik directs the Climate & Energy Program at the Nicholas Institute for Environmental Policy Solutions at Duke University and is a Senior Lecturing Fellow at Duke Law School. Konschnik's work focuses on options for public electric utility regulation and electricity market reforms given emerging technologies and de-carbonization goals. Konschnik has also worked extensively on effective governance of unconventional oil and gas production and transport. Konschnik joined Duke from Harvard Law School, where she founded and directed the Harvard Environmental Policy Initiative and taught as a Lecturer on Law. Previously, Konschnik was Chief Environmental Counsel to U.S. Senator Sheldon Whitehouse, and an Environmental Enforcement Trial Attorney at the U.S. Department of Justice.

Alan Krupnick
Alan Krupnick is a Senior Fellow at Resources for the Future. Krupnick's research focuses on analyzing environmental and energy issues, in particular, the benefits, costs and design of pollution and energy policies, both in the United States and abroad. He leads RFF's research on the risks, regulation and

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economics associated with shale gas development and has developed a portfolio of research on issues surrounding this newly plentiful fuel. Krupnick also served as senior economist on the President's Council of Economic Advisers, advising the Clinton administration on environmental and natural resource policy issues. In 2011 he was elected President of the Association of Environmental and Resource Economists and earlier that year was named an AERE Fellow.

He has served on the Editorial Boards of a number of journals. He co-chaired a federal advisory committee counseling the U.S. Environmental Protection Agency on the implementation of new ozone and particulate standards. He is a regular member of expert committees from the National Academy of Sciences, the USEPA and various Canadian government and non-governmental institutions. Krupnick also consults with state governments, federal agencies, private corporations, the Canadian government, the European Union, the Asian Development Bank, the World Health Organization, and the World Bank. He received his PhD in Economics from the University of Maryland in 1980.

His primary research methodology is in the development and analysis of stated preference surveys (such as contingent valuation and choice experiments), which include eliciting preferences for reductions in mortality risks, environmental risks, tradeoffs involved in improving community drinking water quality with respect to removal of carcinogens versus microbiological agents, and most recently, the risks from shale gas development as seen by experts and the general public.

Tami McMullin

Tami McMullin currently serves as Colorado's state toxicologist, where she also manages the Oil and Gas Health information and Response Program at the Department of Public Health and Environment (CDPHE). She leads research on community health exposures and technical evaluation of the literature on the public health effects potentially associated with oil and gas exposures. Prior to joining CDPHE, Tami worked as a toxicologist and risk assessor in the chemical industry for over a decade where she conducted regulatory testing and safety assessments. Dr. McMullin earned her Bachelor's degree in biology at the University of California San Diego and her Doctoral degree in Environmental Health and Toxicology from Colorado State University.

Charles Thomas (Tom) Moore, Jr.

Tom Moore works for the Western States Air Resources (WESTAR) Council as manager of the Western Regional Air Partnership (WRAP) air quality program, a voluntary partnership of states, tribes, federal land managers, local air agencies and the U.S. EPA, whose purpose is to understand current and evolving regional air quality issues in the context of the Clean Air Act (CAA) and the National Environmental Policy Act (NEPA). His regional analysis and planning support work is conducted through management of a series of interrelated contractor-supported regional projects for the WESTAR and WRAP membership. These diverse and complex projects cover ambient monitoring data analysis, emissions inventory preparation and analysis, regional photochemical grid modeling and source apportionment results, and satellite air quality data. He has worked extensively with both the activity and emissions estimation techniques for electrical generating units, wildland and agricultural fire emissions, oil & gas exploration and production emissions, and ozone and regional haze analysis needs and planning requirements, in support of air quality management programs across the West. A principal emphasis of his work from 2002 to the present is support of Regional Haze planning for the more than 100 Class I areas in the WESTAR-WRAP region. Key western U.S. air quality expertise includes oil & gas production emissions, wildland fire emissions and impacts, regional haze sources and transport, and impacts on the Ozone National Ambient Air Quality Standards from various sources and scales.
He has a B.S. in Physical Geography from Arizona State University in Tempe, with an emphasis on meteorological and glacier field studies, and climate data analysis projects, as well as additional graduate coursework related to air pollution and climate. He has lead numerous air pollution monitoring studies

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and analysis projects, held management positions in state and local government, and worked as an environmental consultant. Before re-joining the WESTAR staff in 2013, he worked for the Western Governors' Association from 2002-13 coordinating and managing WRAP activities. From 1990 to 2001, he designed and managed air quality monitoring and data analysis activities for the Arizona Department of Environmental Quality, where he led the development and implementation of the haze monitoring networks in both urban and remote areas throughout the state. Tom also worked previously for the WESTAR from 1994-96 on an inter-agency personnel assignment, leading a WESTAR project to advise EPA on western U.S. topics and issues with implementation of the national Particulate Matter health and welfare standards.

Robert O'Keefe

Robert O'Keefe is responsible for management of key programs at HEI, including the Institute's global program to assess the health effects of air pollution in developing countries. He also provides leadership in implementing HEI's ongoing research and review programs on the health impact of particulates, ozone air toxics and other pollutants, and emerging technologies and fuels, including those driven by climate concerns. He oversaw the Institute's efforts to define and implement a program of research on Accountability, a first-of-its-kind program designed to understand the health impacts of environmental regulation. He is regularly called on to address prominent institutions, including the U.S. Congress, the European Parliament, the National Academy of Science's National Research Council and Institute of Medicine, and many other domestic and international bodies. In 2009 he was invited by the Woodrow Wilson Center to address its congressional forum as a "Scholar on the Hill." He is currently a member of the U.S. EPA's national Clean Air Act Advisory Committee and is Chair of the Board of Directors of Clean Air Asia. Before coming to HEI he served for nine years at the Massachusetts Department of Environmental Protection, as Assistant Deputy Commissioner for Policy and Program Development and as Director of Planning and Budget. Mr. O'Keefe played a significant role in gaining passage and funding for major state programs, including the Massachusetts State Superfund law, the Safe Drinking Water Program, and the design and funding of Massachusetts' implementation of the 1990 Clean Air Act amendments.

Kelly Rose

Kelly Rose is a geo-data science researcher with the National Energy Technology Laboratory's (NETL) Research Innovation Center. Her research at NETL is focused on using geologic and geospatial science to reduce uncertainty about, characterize and understand spatial relationships between energy, engineered-natural systems at a range of scales. Her work involves development of new data-driven methods and tools for analysis of offshore energy, oil & gas, rare earth element, groundwater, carbon storage, and geothermal systems. Rose's research interests also include development of software driven solutions to common science-data curation, discovery and inter-operability challenges. She has served on advisory committees including the Department of Interior's National Geologic and Geophysical Data Preservation Program, United Nations Environmental Programme's global outlook on methane gas hydrates, and the University of Southern California's Induced Seismicity and Reservoir Monitoring Consortiums. She is associate editor for the Journal of Sustainable Energy Engineering and is also NETL's Technical Portfolio Lead for the Advanced Offshore Energy Research Portfolio https://edx.netl.doe.gov/offshore. Rose is Principal investigator for NETL's Energy Data eXchange (EDX), an online, public and private research curation and virtual laboratory platform developed by Rose and the EDX team for DOE FE, https://edx.netl.doe.gov. Rose is co-author of 1 patented, 1 trademarked, 1 copyrighted, 10 custom tools, and more than 100 published technologies and studies. Throughout her career at NETL, Rose has had the honor of mentoring and working with more than forty-five STEM research interns and fellows. She holds geology degrees from Denison University, B.S., Virginia Tech, M.S., and Oregon State University, Ph.D.

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Anna Rosofsky
Anna Rosofsky is a Staff Scientist at HEI with expertise in environmental and spatial epidemiology. Rosofsky joined HEI in 2017 as part of the Energy Research Program. In this role, Rosofsky supports technical work within and implementation of the Strategic Scientific Research Agenda to understand potential human exposure and health impacts from unconventional oil and gas development. Rosofsky recently received a Ph.D. in Environmental Health from Boston University School of Public Health, where she studied spatiotemporal patterns of ambient air pollution exposure and early-childhood health impacts. Prior to her doctoral studies, Rosofsky investigated environmental health disparities at the Center for Puerto Rican Studies and at the Mosakowski Institute for Public Enterprise. She received an M.A. in Environmental Science and Policy from Clark University.

Martha E. Rudolph
Martha Rudolph is the Director of Environmental Programs for the Colorado Department of Public Health and Environment where she oversees the Air Quality, Environmental Health and Sustainability, Hazardous Materials and Waste Management, and Water Quality Divisions. Ms. Rudolph has been with the Department since 2007 and served as the Executive Director of the Department in 2010. In 2015/2016, Ms. Rudolph was President of the Environmental Council of States, the national non-profit, non-partisan association of state and territorial environmental agency leaders. She currently serves on the Board of Directors for the Environmental Research Institute of the States and is a co-chair of the ECOS Shale Gas Caucus. Previously Ms. Rudolph was the Chair of the ECOS Air Committee and the Vice Chair of the ECOS Planning Committee. She is a member of the Division on Earth and Life Studies of The National Academies of Sciences, Engineering, and Medicine, a state advisor for the Georgetown Climate Center, and a member of the American College of Environmental Lawyers. A graduate of the Georgetown University Law Center, Ms. Rudolph is an environmental attorney, and served for 14 years in the Colorado Attorney General's Office. She has been in private practice in Denver, and was an assistant general counsel for Kinder Morgan Inc., a natural gas and energy transportation company. Ms. Rudolph received her BA in International Affairs from the University of Colorado-Boulder and Doctor of Law degree from the Georgetown University Law Center.

Scott Thompson
Scott Thompson has served as the executive director of the Oklahoma Department of Environmental Quality since December 2013. In that role, Thompson has implemented new approaches to environmental permitting and enforcement in Oklahoma with the goal of helping make the state more prosperous and economically viable. Prior to becoming executive director, Thompson led DEQ's Land Protection Division, where he managed a diverse set of programs, including Superfund, Brownfields, Voluntary Cleanup, and Radiation Management. Thompson has a biology degree from Central State University. He also has a master's degree in environmental science from the University of Oklahoma.

Donna J. Vorhees
Donna Vorhees directs the Energy Research Program at HEI. She is leading an effort to implement a Strategic Scientific Research Agenda designed to understand potential human exposures and health effects from unconventional oil and gas development and how they might be prevented or minimized. Vorhees has 25 years of consulting experience, assessing multi-pathway chemical exposures in indoor and outdoor environments, quantifying human health risks, and communicating risks to affected communities in the United States on behalf of government and private clients and internationally on behalf of the United Nations Environment Program. She serves on the U.S. EPA Board of Scientific Counselors Subcommittee on Chemical Safety for Sustainability and previously served on National Research Council committees (Health Risks of Phthalates and Sediment Dredging at Superfund Megasites), other advisory committees, and peer review panels for numerous health risk assessments prepared by the U.S. EPA, the Consumer Product Safety Commission, and Health Canada. She is Adjunct

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Assistant Professor at the Boston University School of Public Health where she teaches Risk Assessment Methods. Vorhees received her ScM and ScD in Environmental Health from the Harvard School of Public Health.

Tao Wen
Tao Wen received his PhD in Geology from the University of Michigan in 2017 and is currently a Postdoctoral Scholar in the Earth and Environmental Systems Institute at Penn State University. He completed his B.S. degree in Environmental Sciences at the University of Science and Technology of China in 2011. He has extensively worked on characterizing the formation and migration of natural gas (conventional and unconventional) and has assessed the environmental impacts of hydrocarbon recovery activities on water quality across a few major shale plays (i.e., Antrim Shale, Barnett Shale, and Marcellus Shale) in the U.S. During his research, Tao has blended field geology, state-of-the-art geochemical analyses, as well as emerging data mining (big data) tools in his research. More details about Tao Wen can be found at http://jaywen.com/.

Clint Woods
Clint Woods serves as Deputy Assistant Administrator in U.S. EPA's Office of Air and Radiation. Prior to joining EPA in December 2017, Clint was the Executive Director of the Association of Air Pollution Control Agencies (AAPCA), a non-profit organization of state and local air quality agencies located in Lexington, Kentucky. While with AAPCA, he was also a member of U.S. EPA's National Advisory Council on Environmental Policy and Technology. Clint previously served as a professional staff member with the Committee on Science, Space, and Technology in the U.S. House of Representatives, the Energy, Environment, and Agriculture Task Force at the American Legislative Exchange Council, and Manager of Government Affairs with the Recreation Vehicle Industry Association. He holds an MA in international commerce and policy from George Mason University and a BA from the University of Mary Washington.

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HEI Research Planning Workshop

Understanding Population-Level Exposures Associated with Onshore Development of Oil and Natural Gas from Unconventional Resources

Austin, TX
September 12-13, 2018

PARTICIPANTS

Dr. John Adgate
Professor and Chair, Department of Environmental and Occupational Health
Colorado School of Public Health

Dr. David Allen
Melvin H. Gertz Regents Chair in Chemical Engineering
University of Texas Austin

Mr. Dan Arthur
Founding Member and Managing Partner
ALL Consulting

Mr. Bruce Baizel
Director, Energy Program, Oil & Gas Accountability
Earthworks

Mr. Rodney Barnwell
Counsel – Environmental & Safety
XTO Energy Inc.

Ms. Uni Blake
Scientific Advisor
American Petroleum Institute

Dr. Tiffany Bredfeldt
Toxicologist, Toxicology Division
Texas Commission on Environmental Quality

Dr. Adelita Cantu
Associate Professor
University of Texas Health San Antonio

Dr. Joan Casey
Postdoctoral Scholar, Environmental Health Sciences Division
University of California at Berkeley

Dr. Isabelle Cozzarelli
Hydrologist
United States Geological Survey

Dr. Elena Craft
Senior Health Scientist
Environment Defense Fund

Dr. Eric Daniels
Consulting Hydrogeologist
Chevron

Dr. Dennis Devlin
Senior Environmental Health Advisor
ExxonMobil Corporation

***Dr. Shari Dunn-Norman**
Associate Professor of Geosciences, Geological, and Petroleum Engineering
Missouri University of Science and Technology

Mr. Steve Ellison
Attorney
ConocoPhillips

*** HEI Energy Research Committee Members
^ Speakers and Panelists

***Dr. Elaine Faustman**
Professor and Director of the Institute of Risk Analysis and Risk Communication
University of Washington

Ms. Kate Fay
Environmental and Regulatory Policy Manager
Noble Energy

Mr. Howard Feldman
Senior Director, Regulatory and Scientific Affairs
American Petroleum Institute

Mr. Dick Francis
Manager, Reglatory Policy
Shell Oil Company

^**Ms. Megan Garvey**
Senior Counselor to the Regional Administrator
United States Environmental Protection Agency-Region 8

Mr. Andrew Glickman
Manager (Retired)
Chevron

Dr. Gretchen Goldman
Research Director, Center for Science and Democracy
Union of Concerned Scientists

Dr. Bernard Goldstein
Professor and Dean Emeritus
University of Pittsburgh Graduate School of Public Health

Ms. Vicki Goodenow
Principal Consultant-Safety and Sustainability
Equinor

Dr. Alea Goodmanson
Scientist
Chevron

Mr. John Grant
Managing Consultant
Ramboll

Mr. Daniel Greenbaum
President
Health Effects Institute

Dr. Stephanie Hasanali
MHM Research Contractor
Pennsylvania Department of Health

Dr. Paul Hodgins
Chief Medical Officer
ConocoPhillips

^**Dr. Michael Honeycutt**
Director, Toxicology Division
Texas Commission on Environmental Quality

^***Dr. George Hornberger**
Professor of Engineering, Professor of Civil and Environmental Engineering, Professor of Earth and Environmental Sciences, and Director, Vanderbilt Institute for Energy and Environment
Vanderbilt University

^**Dr. Rebecca Hornbrook**
VOC Measurements Group
University Corporation for Atmospheric Research

***Dr. Howard Hu**
Affiliate Professor, Environmental and Occupational Health Sciences
University of Washington

Mr. Charles Ingebretson
Partner
AJW, Inc.

^**Mr. James Kenney**
Senior Policy Advisor for Unconventional Oil and Gas
United States Environmental Protection Agency

Ms. Kristin Koblis
Senior Occupational Health Advisor
Noble Energy

*** HEI Energy Research Committee Members
^ Speakers and Panelists

^Dr. Kate Konschnik
Director, Climate and Energy
Duke University

^Dr. Alan Krupnick
Senior Fellow
Resources for the Future
***Dr. Judy LaKind**
President
LaKind Associates, LLC

Mr. Matt Lepore
Strategic Advisor & Legal Counsel
Adamantine Energy

Dr. Karlene Lavelle
Advanced Epidemiology Associate
ExxonMobil Corporation

Mr. Rob Lawrence
Policy Advisor – Energy Issues
United States Environmental Protection Agency-Region 6

Ms. Kathryn Liziewski
Research Assistant
Health Effects Institute

Dr. Lisa McKenzie
Assistant Research Professor
Colorado School of Public Health

^Dr. Tami McMullin
State Toxicologist
Colorado Department of Public Health and Environment

Mr. C. Andrew Miller
Associate Director for Climate
United States Environmental Protection Agency

^Mr. Tom Moore
WRAP Air Quality Program Manager
Western States Air Resources Council

Dr. Ziad Naufal
Health and Workforce Safety
Chevron

^Mr. Robert O'Keefe
Vice President
Health Effects Institute

Dr. Adam Pacsi
Air Technology Engineer
Chevron

Mr. Wil Porche
Technical Operations Lead, Safety Security Health & Environmental
XTO Energy Inc.

Mr. Jason Redus
Senior Industrial Hygienist
Pioneer Natural Resources

^Dr. Kelly Rose
Geology and Geo-Data Science Researcher
National Energy Technology Laboratory

^Dr. Anna Rosofsky
Staff Scientist
Health Effects Institute

^Ms. Martha Rudolph
Director, Environmental Programs
Colorado Department of Public Health and Environment

***Dr. Armistead (Ted) Russell**
Howard T. Tellepsen Chair and Regents' Professor
Environmental Engineering
Georgia Institute of Technology

Dr. Stefanie Ebelt Sarnat
Associate Professor
Emory University

Dr. Gunnar Schade
Associate Professor, Atmospheric Sciences
Texas A&M University

Ms. Kim Schultz
Oil and Gas Program Coordinator
The Endocrine Disruption Exchange

*** HEI Energy Research Committee Members
^ Speakers and Panelists

Dr. Rashid Shaikh
Director of Science
Health Effects Institute

Mr. Robert Shavers
Operations Manager
Health Effects Institute

Dr. Daniel Soeder
Director, Energy Resources Initiative
South Dakota School of Mines & Technology

Ms. Delya Sommerville
Public Health, Health Informatics & Systems Director
BP

Dr. Kevin Teichman
Deputy Assistant Administrator for Science, Office of Research and Development
United States Environmental Protection Agency

^Mr. Scott Thompson
Executive Director
Oklahoma Department of Environmental Quality

Mr. Lance Tolson
Senior Legal Counsel - P&T Global Safety & Environment
Shell Oil Company

Ms. Denise Tuck
Principal Product Champion, Production Enhancement
Halliburton

^Dr. Donna Vorhees
Director of Energy Research
Health Effects Institute

^Dr. Tao Wen
Postdoctoral Fellow
The Pennsylvania State University

Dr. Judy Wendt Hess
Epidemiologist
Shell Oil Company

Dr. Kristina Whitworth
Assistant Professor, Department of Epidemiology, Human Genetics & Environmental Sciences
The University of Texas Health Science Center at Houston

Ms. Lindsay Wilcock
Health and Industrial Hygiene Team Leader
BP Lower 48 Exploration and Production

^Mr. Clint Woods
Deputy Assistant Administrator, Office of Air and Radiation
United States Environmental Protection Agency

*** HEI Energy Research Committee Members
^ Speakers and Panelists

HEI Energy Research Program – Research Planning Workshop
September 12-13, 2018

Travel Guide

Hotel:
Hilton Austin, Governor's Ballroom – Salon B
500 East 4th Street, Austin, Texas 78701

Transportation between the Austin-Bergstrom International Airport and the Hilton Austin

The Hilton Austin is 11 miles from Austin-Bergstrom International Airport. Local taxis are available, as well as Uber, Lyft, and Ride Austin (a locally based ridesharing service like Uber and Lyft). A Lyft will cost ~$13 and will take about 20 minutes depending on traffic.